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THE EFFECT OF AN INDIVIDUALLY PRESCRIBED INSTRUCTION PROGRAM IN ARITHMETIC ON PUPILS AT DIFFERENT ABILITY LEVELS.

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*ABILITY GROUPING, *PERFORMANCE FACTORS, *PROGRAMED INSTRUCTION, *ARITHMETIC, *ELEMENTARY SCHOOL STUDENTS, COMPARATIVE ANALYSIS, HIGH ACHIEVERS, LOW ACHIEVERS, ACHIEVEMENT TESTS, INDIVIDUAL INSTRUCTION, PITTSBURGH, PENNSYLVANIA, INDIVIDUALLY PRESCRIBED INSTRUCTION (IPI)

A STUDY WAS CONDUCTED OF THE DIFFERENCES AMONG PUPILS OF DIFFERING ABILITY LEVELS BOTH IN PROGRESS AND ACHIEVEMENT. A COMPARISON OF THESE DIFFERENCES WAS THEN MADE WITH THOSE USING CONVENTIONAL INSTRUCTION PROGRAMS. TWENTY-THREE HYPOTHESES WERE TESTED TO DETERMINE IF SIGNIFICANT DIFFERENCES EXISTED AMONG LOW-, AVERAGE-, AND HIGH-ABILITY STUDENTS IN DIFFERENT GRADE LEVELS IN SCORES ON ARITHMETIC ACHIEVEMENT TESTS. THE EXPERIMENTAL GROUP CONSISTED OF 66 FOURTH-, FIFTH-, AND SIXTH-GRADE STUDENTS OF DIFFERING ABILITY LEVELS. ALL OF THESE STUDENTS STUDIED ARITHMETIC UNDER THE INDIVIDUALLY PRESCRIBED INSTRUCTION (IPI) PROGRAM. THE CONTROL GROUPS CONSISTED OF 399 STUDENTS MATCHED IN ABILITY AND GRADE LEVELS AS THE EXPERIMENTAL GROUP. THESE STUDENTS RECEIVED ARITHMETIC IN A TRADITIONAL CLASSROOM PROGRAM. VARIOUS ACHIEVEMENT MEASURES WERE IMPOSED FOR DATA COLLECTION. ANALYSIS OF COVARIANCE WAS USED TO TEST THE SIGNIFICANT DIFFERENCES. THE FINDINGS INDICATED, IN GENERAL, HIGHER ABILITY STUDENTS PERFORMED AND MASTERED MORE THAN DID THE LOWER ABILITY STUDENTS UNDER THE IPI PROGRAM. THE CONCLUSIONS INDICATED, HOWEVER, NO SIGNIFICANT DIFFERENCE WAS FOUND AMONG HIGH-, AVERAGE, AND LOW-ABILITY STUDENTS IN ARITHMETIC PROBLEM-SOLVING SCORES WHEN ACCOUNTING FOR PRETEST PERFORMANCE. A NUMBER OF RECOMMENDATIONS FOR FURTHER RESEARCH WERE DISCUSSED. (RS)

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THE EFFECT OF AN INDIVIDUALLY PRESCRIBED INSTRUCTION PROGRAM IN ARITHMETIC ON PUPILS AT DIFFERENT ABILITY LEVELS

by

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FOREWORD

The research and development reported herein was performed pursuant to a contract with the United States Office of Education, Department of Health, Education and Welfare under the provisions of the Cooperative Research Program.

The writer is deeply grateful to his dissertation advisor, Dr. C.M. Lindvall, for his encouragement and capable direction of this study. Special acknowledgement is extended to Dr. Maurice J. Thomas, his major advisor, for his assistance and counseling during the writer's graduate work at the University of Pittsburgh, and for serving on his doctoral committee. Sincere appreciation is also extended to Dr. John O. Bolvin, Dr. Richard C. Cox, and Dr. Herbert Olander, members of the doctoral committee, for their appraisals and helpful suggestions.

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I. INTRODUCTION AND REVIEW OF RELATED RESEARCH

It is generally recognized that some of the major problems and challenges encountered in classroom instruction are related to individual differences existing among pupils. Children have different backgrounds, goals, aspirations, motivations and abilities which should be taken into consideration in the instructional process.

Clymer and Kearney[1] point out the existence of individual differences in "problem solving, reading ability, spelling ability, visual and auditory acuity, language skills, height and weight, dexterity, readiness to learn, interest, emotional stability, persistence, motivation, ability to work alone, cooperativeness and other social, personal, intellectual and academic characteristics." Goodlad and Anderson[2] emphasize differences in achievement with the following three statements:

1. Individual children's achievement patterns differ markedly from learning area to learning area.
2. Children entering the first grade differ in mental age by approximately four full years.
3. Pupils in the fourth grade differ by as much as four years in mental age and achievement, in the fifth grade by five years, and in the sixth grade by six years.

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[1] Theodore Clymer and Nolan C. Kearney, "Curriculum and Instructional Provisions for Individual Differences," NSSE Yearbook, Individualized Instruction, Nelson B. Henry (Ed.), Chicago: University of Chicago Press, 1962, Pp. 267-268.

[2] John I. Goodlad and Robert H. Anderson, The Nongraded Elementary School, Revised, New York: Harcourt, Brace and World, Inc., 1963, Pp. 6-13.

In arithmetic reasoning and computation, Cook[1] indicates that the range in achievement is between six and seven years at the sixth grade level. Grossnickle and Brueckner state:

> Perhaps the most important fact that has been revealed by educational measurement, as far as instruction in arithmetic is concerned, is the wide range of individuals in achievement and intelligence in any typical class in our schools.[2]

Recognition of the existence of individual differences had led to attempts to alter school programs and facilities accordingly. These efforts have taken a variety of forms and have met with varying degrees of success. When a school system makes an adaptation in order to meet individual differences, an improvement in the achievement scores usually results.

The majority of efforts attempted have dealt with some type of ability grouping. Ability grouping, however, does not solve the problem of individual differences completely, for not only is there variability among groups of children but also variability exists in the skills and abilities of a single child. In a study of 107 ninth grade boys, Hull[3] reported that:

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[1] Walter W. Cook, "The Functions of Measurement in the Facilitation of Learning," Educational Measurement, E. F. Lindquist (Ed.), Menasha, Wisconsin: George Bauto Publishing Company, 1955, p. 11.

[2] Foster E. Grossnickle and Leo J. Brueckner, Discovering Meanings in Arithmetic, New York: Holt, Rinehart and Winston, 1959, p. 373.

[3] Clark L. Hull, "Variability in Amount of Different Traits Possessed by the Individual," Journal of Educational Psychology, 18, 1927, Pp. 97-104.

1. Trait differences in the typical individual were 80% as great as individual differences in the total group.
2. Trait differences tend to conform to the normal curve.
3. No relationship exists between the individual's general level of ability and the extent of his trait variability.

Goodlad[1] contends that grouping children for likeness in one trait creates groups of wide differences in many other traits. He also indicates that students grouped for likeness in a trait are not alike on sub-elements of that trait.

With inter- and intra-individual differences, it seems desirable to have instruction within our schools guided toward each individual and not to any special group. Instruction should "permit each pupil to progress at the rate which is normal for him whether that rate be rapid or slow."[2] A child should receive the opportunity to pursue his education at his optimum pace rather that at an average pace which has been set for some heterogeneous group and also should be allowed to pursue course work on a level geared to his current ability to achieve.[3]

Corle states:

> Learning is an individual matter, and every boy and girl in an elementary class achieves skill in arithmetic at his own rate

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[1] John I. Goodlad, "Meeting Children Where They Are," Saturday Review, March 20, 1965, p. 59.

[2] Lewis W. Terman, The Measurement of Intelligence, Boston: Houghton-Mifflin Company, 1916, p. 4.

[3] Richard W. Burns and Mary B. Craik, "Let the Learner Learn," Education, Vol. 85, November, 1964, Pp. 155-157.

> and in his own way. There is little likelihood that any two pupils, even in a homogeneously grouped class, will be alike in quantitative aptitude, interest, achievement, or motivation.[1]

Considerable research has been done pertaining to the effectiveness of various methods of individualizing instruction. Many studies have been concerned with comparison of the relative success of individualized instruction and a "conventional" or "traditional" instructional method. The results of these studies tend to favor the experimental group, which was taught under individualized instruction, over the control group which was taught in the traditional manner.

Grant[2] found insufficient evidence to reject the null hypothesis that: "The achievement of students in the individualized program would not differ significantly from the achievement of students of comparable age and ability in the same school or from the norm." Differences in gain, however, did suggest that there was a trend to achievement that favored students in the individualized program. He used differentiated materials and measured gains in arithmetic reasoning and computation on the Stanford Achievement Test for his experimental and control groups.

Riedesel[3] attempted to individualize instruction by having his experimental group of sixth graders use lessons which were prepared on two levels of difficulty. When compared to a control group taught traditionally, there was a significant difference between the .05 and .10 level favoring the experimental group.

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[1] Clyde Corle, Teaching Mathematics in the Elementary School, New York: The Ronald Press, 1964, p. 356.

[2] Jettye Fern Grant, A Longitudinal Program of Individualized Instruction in Grades 4, 5, and 6, (Doctoral Thesis), University of California, 1964.

[3] Clark Alan Riedesel, Procedures for Improving Verbal Problem-Solving Ability in Arithmetic, (Doctoral Thesis), State University of Iowa, 1962.

Schunert[1] studied a number of factors which seemed related to achievement in mathematics. Among other things, he found that regular use of differentiated assignments rather than identical assignments was positively correlated with achievement in algebra.

Lerch,[2] by pretesting students, was able to place them in instructional units. When comparing this group to a comparable control group the results indicated a significant difference in arithmetic achievement favoring the experimental group.

As mentioned previously, these studies were mainly concerned with the comparison of the effectiveness of individualized instruction and traditional instruction. The classes were composed of pupils of varying levels of ability but the results were reported for the group as a whole. There have been a few studies that have singled out different ability-level students and the derived benefits from individualized instruction for each group. There is evidence that children of a wide range of intelligence learn in different ways and those at a given intelligence level may learn better with a particular method. For example, whenever a well-defined sequence of programmed instruction was used the lower ability group students obtained mean scores on an achievement test that were equal to that of the highest ability group. But when a poorer sequence of programmed instruction was used the lower ability group obtained scores that were significantly lower than the higher ability group.[1]

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[1] James Schunert, "The Association of Mathematical Achievement With Certain Factors Resident in the Teacher, in the Teaching, in the Pupils, and in the School," Journal of Experimental Education, Vol. 19, 1951, Pp. 219-238.

[2] Harold Hubert Lerch, A Study Concerning the Adjustment of Arithmetic Instruction to Certain Individual Differences, (Doctoral Thesis), University of Illinois, 1960.

Klausmeier and Laughlin[2] reported that bright and slow children react differently when solving a problem. Bright children were independent in correcting their own mistakes, presented unifying solutions, and gave logical approaches to the solutions of problems. The slow children lacked persistence, gave incorrect solutions, and used random processes in solving problems. It has also been reported that low, average, and high intelligence children do not differ significantly in retention whenever the learning task was graded to each child's achievement level.[3] These studies suggest that it may be important to study the effectiveness of any method of instruction on children of different abilities.

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[1] M. H. Detamble and L. M. Stolurow, "Stimulus Sequence and Concept Learning," Journal of Experimental Psychology, Vol. 51, 1956, Pp. 34-40.

[2] Herbert J. Klausmeier and L. J. Laughlin, "Behaviors During Problem Solving Among Children of Low, Average, and High Intelligence," Journal of Educational Psychology, Vol. 52, June, 1961, Pp. 148-152.

[3] Herbert J. Klausmeier and John Check, "Retention and Transfer in Children of Low, Average, and High Intelligence," Journal of Educational Research, Vol. 55, April, 1962, Pp. 319-322.

Evidence has also been reported which indicates that individualized instruction may be particularly helpful for the average and below average students.

Finley[1] found that mentally retarded children perform significantly better than normal children in arithmetic whenever test items were presented in a symbolic context.

Bernstein[2] and Tilton[3] both showed satisfactory results in studies involving slow children. In Bernstein's study, the students under individualized instruction achieved twice as much in less time than did the remedial students in the group instruction method. Tilton found that students in an experimental group made five months more progress in addition, subtraction, and multiplication skills than did a control group. This difference was significant at the .01 level.

In studies where efforts have been made to compare the effectiveness of individualization when used with slow, average, and bright students, the results are somewhat conflicting. Several of the studies have used essentially homogeneous grouping procedures and have found this to be more effective for the slow and average students. Jones[1] and Spence[2] used three sub-groups within a class, while Durrell[3] had three to five students working as a team within each classroom. Differentiated instructional materials were used and the results of all three studies favored individualization with the slow and average student rather than the bright. However, when Dewar[4] used sub-grouping and differentiated materials, both the bright and slow groups showed significant gains.

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[1] Carmen J. Finley, "Arithmetic Achievement in Mentally Retarded Children: The Effects of Presenting the Problem in Different Contexts," American Journal of Mental Deficiency, Vol. 67, September, 1962, Pp. 281-286.

[2] Allen L. Bernstein, A Study of Remedial Arithmetic Conducted with Ninth Grade Students, (Doctoral Thesis), Wayne University, 1955.

[3] J. W. Tilton, "Individualized and Meaningful Instruction in Arithmetic," Journal of Educational Psychology, Vol. 38, February, 1947, Pp. 83-88.

Triplett[5] used differentiated materials in the teaching of fractions. Along with finding a significant difference in computation and problem solving favoring the experimental group, a significant difference was also found among the three ability groups favoring the slow and average over the bright group.

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[1] Daisy Marvel Jones, "An Experiment in Adaptation to Individual Differences," Journal of Educational Psychology, Vol. 39, 1948, Pp. 257-272.

[2] Eugene S. Spence, Intra-Class Grouping of Pupils for Instruction in Arithmetic in the Intermediate Grades of the Elementary School, (Doctoral Thesis), University of Pittsburgh, 1958.

[3] Donald D. Durrell, "Adapting Instruction to the Learning Needs of Children in Intermediate Grades," Journal of Education, Vol. 142, December, 1959, Pp. 2-78.

[4] John Alexander Dewar, An Experiment in Intra-Class Grouping for Arithmetic Instruction in the Sixth Grade, (Doctoral Thesis), University of Kansas, 1961.

[5] Le Triplett, An Investigation to Determine What Influence the Use of Differentiated Written Materials has Upon Sixth Grade Students' Achievement and Understanding in Multiplication of Fractions When Compared with the Single Textbook Approach, (Doctoral Thesis), Colorado State College, 1962.

On the other hand, in studies where each pupil has been permitted to proceed as quickly as his own individual ability will permit, there is some indication that the brighter pupils may profit most in achievement.

Reed and Hayman[1] used programmed materials with high, average, and low ability students in the Denver Public Schools. The results indicated that the accelerated classes learned significantly more from the program than from conventional practice. The slower children, however, did significantly better with conventional classroom practice than with the program. In Chicago area schools where programmed materials were also used, Schramm[2] reported that the experimental group of students with IQ's below 111 made the poorest showing when compared to a control group. The other two categories of IQ used in the study were 111-125 and over 125.

Fincher[3] experimented with a self-constructed programmed textbook. The results of his study indicated a direct relationship between IQ level of children and achievement. The children with higher IQ's showed significant mean gains in achievement and also significant differences in retention scores.

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[1] Jerry E. Reed and John L. Hayman, "Report of Research," Denver Public Schools, Denver, Colorado, English 2600, Division of Instructional Services, 1960-1961, Mimeographed, 1961.

[2] Wilbur Schramm, Four Case Studies of Programmed Instruction, Fund for the Advancement of Education, New York: 1964, p. 46.

[3] Glen E. Fincher, The Construction and Experimental Application of a Programmed Course on the Addition and Subtraction of Fractions for Grade Five, (Doctoral Thesis), Ohio State University, 1965.

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solve the problem of individual differences. Whenever pupils were categorized into ability groups an artificial ceiling was introduced which restricted the average, bright, and slow child in the amount of instruction that it was possible for him to receive.

Teaching machines and programmed instruction were thought to be possible solutions to the problem of individual differences, but the problem of providing for inter- and intra-individual differences was still present whenever these materials were used.

Whenever studies pertaining to individualized instruction took into account the different ability levels of children, the results were somewhat conflicting as to whether the high, average, or low ability child receives the most benefit. Further research is needed to determine the benefactor of such instruction. It may well be that if pupils are permitted to proceed in accordance with their own individual abilities, and if some variety in the type of study materials is provided, pupils at all ability levels may be expected to profit from individualized instruction. The present problem studied the effects of an Individually Prescribed Instruction project on progress and achievement in arithmetic of high, average, and low ability children in the intermediate grades of an elementary school.

II. THE PROBLEM

A. Statement of the Problem

Is there a difference among pupils at different ability levels in their progress and achievement under Individually Prescribed Instruction and how do any such differences compare with those found in schools using more conventional programs of instruction?

B. The Hypotheses

In order to determine whether or not there were differences in the progress of different ability level students in the Individually Prescribed Instruction program the following data pertaining to the fourth, fifth, and sixth grades at Oakleaf Elementary School were compiled:

(1) Number of days each student attended school.

(2) Number of skills a student completed or mastered in a school year.

(3) Number of units a student mastered by doing assigned tasks in a school year.

(4) Number of units mastered by a pretest score of 85% or above in a school year.

(5) Total units.

In order to determine if there were any significant differences among low, average, and high ability students in each of the three grade levels in their scores on arithmetic achievement tests the following hypotheses were tested. (In examining these hypotheses it should be kept in mind that the Oakleaf School students constitute the experimental group while each of the other schools provides an independent control group.)

1. There is no significant difference among the mean achievement scores in arithmetic computation on the Metropolitan Achievement Test given in May, 1965 for low, average, and high ability fourth grade students at Oakleaf Elementary School under Individually Prescribed Instruction when the achievement scores from May, 1964 are used as covariates.

2. There is no significant difference among the mean achievement scores in arithmetic computation on the Metropolitan Achievement Test given in May, 1965 for low, average, and high ability fourth grade students of MacAnnulty Elementary School under traditional instruction when the achievement scores from May, 1964 are used as covariates.

3. There is no significant difference among the mean achievement scores in arithmetic computation on the Metropolitan Achievement Test given in May, 1965 for low, average, and high ability fourth grade students of McGibney Elementary School under traditional instruction when the achievement scores from May, 1964 are used as covariates.

4. There is no significant difference among the mean achievement scores in arithmetic computation on the Metropolitan Achievement Test given in May, 1965 for low, average, and high ability fourth grade students of Rolling Hills Elementary School under traditional instruction when the

achievement scores from May, 1964 are used as covariates.

5. There is no significant difference among the mean achievement scores in arithmetic problem solving on the Metropolitan Achievement Test given in May, 1965 for low, average, and high ability fourth grade students of Oakleaf Elementary School under Individually Prescribed Instruction when the achievement scores from May, 1964 are used as covariates.
6. There is no significant difference among the mean achievement scores in arithmetic problem solving on the Metropolitan Achievement Test given in May, 1965 for low, average, and high ability fourth grade students of MacAnnulty Elementary School under traditional instruction when the achievement scores from May, 1964 are used as covariates.
7. There is no significant difference among the mean achievement scores in arithmetic problem solving on the Metropolitan Achievement Test given in May, 1965 for low, average, and high ability fourth grade students of McGibney Elementary School under traditional instruction when the achievement scores from May, 1964 are used as covariates.
8. There is no significant difference among the mean achievement scores in arithmetic problem solving on the Metropolitan Achievement Test given in May, 1965 for the low, average,

and high ability fourth grade students of Rolling Hills Elementary School under traditional instruction when the achievement scores from May, 1964 are used as covariates.

9. There is no significant differences among the mean achievement scores in arithmetic computation on the Metropolitan Achievement Test given in May, 1965 for low, average, and high ability fifth grade students of Oakleaf Elementary School under Individually Prescribed Instruction when the achievement scores from May, 1964 are used as covariates.

10. There is no significant difference among the mean achievement scores in arithmetic computation on the Metropolitan Achievement Test given in May, 1965 for low, average, and high ability fifth grade students of MacAnnulty Elementary School under traditional instruction when the achievement scores from May, 1964 are used as covariates.

11. There is no significant difference among the mean achievement scores in arithmetic computation on the Metropolitan Achievement Test given in May, 1965 for low, average, and high ability fifth grade students of McGibney Elementary School under traditional instruction when the achievement scores from May, 1964 are used as covariates.

12. There is no significant difference among the mean achievement scores in arithmetic computation on the Metropolitan

Achievement Test given in May, 1965 for low, average, and high ability fifth grade students of Rolling Hills Elementary School under traditional instruction when the achievement scores from May, 1964 are used as covariates.

13. There is no significant difference among the mean achievement scores in arithmetic problem solving on the Metropolitan Achievement Test given in May, 1965 for low, average, and high ability fifth grade students of Oakleaf Elementary School under Individually Prescribed Instruction when the achievement scores from May, 1964 are used as covariates.

14. There is no significant difference among the mean achievement scores in arithmetic problem solving on the Metropolitan Achievement Test given in May, 1965 for low, average, and high ability fifth grade students of MacAnnulty Elementary School under traditional instruction when the achievement scores from May, 1964 are used as covariates.

15. There is no significant difference among the mean achievement scores in arithmetic problem solving on the Metropolitan Achievement Test given in May, 1965 for low, average, and high ability fifth grade students of McGibney Elementary School under traditional instruction when the achievement scores from May, 1964 are used as covariates.

16. There is no significant difference among the mean achievement scores in arithmetic problem solving on the Metropolitan Achievement Test given in May, 1965 for low, average, and high ability fifth grade students of Rolling Hills Elementary School under traditional instruction when the achievement scores from May, 1964 were used.

17. There is no significant difference among the mean achievement scores in arithmetic computation on the Stanford Achievement Test given in May, 1965 for low, average, and high ability sixth grade students of Oakleaf Elementary School under Individually Prescribed Instruction when the achievement scores from May, 1964 are used as covariates.

18. There is no significant difference among the mean achievement scores in arithmetic computation on the Stanford Achievement Test given in May, 1965 for low, average, and high ability sixth grade students of MacAnnulty Elementary School under traditional instruction when the achievement scores from May, 1964 are used as covariates.

19. There is no significant difference among the mean achievement scores in arithmetic computation on the Stanford Achievement Test given in May, 1965 for low, average, and high ability sixth grade students of McGibney Elementary School under traditional instruction when the achievement scores from May, 1964 are used as covariates.

20. There is no significant difference among the mean achievement scores in arithmetic computation on the Stanford Achievement Test given in May, 1965 for low, average, and high ability sixth grade students of Rolling Hills Elementary School under traditional instruction when the achievement scores from May, 1964 are used as covariates.

21. There is no significant difference among the mean achievement scores in arithmetic problem solving on the Stanford Achievement Test given in May, 1965 for low, average, and high ability sixth grade students of Oakleaf Elementary School under Individually Prescribed Instruction when the achievement scores from May, 1964 are used as covariates.

22. There is no significant difference among the mean achievement scores in arithmetic problem solving on the Stanford Achievement Test given in May, 1965 for low, average, and high ability sixth grade students of MacAnnulty Elementary School under traditional instruction when the achievement scores from May, 1964 are used as covariates.

23. There is no significant difference among the mean achievement scores in arithmetic problem solving on the Stanford Achievement Test given in May, 1965 for low, average, and high ability sixth grade students of McGibney Elementary School under traditional instruction when the achievement scores from May, 1964 are used as covariates.

III. DESCRIPTION OF THE SCHOOL DISTRICT, STUDENTS, AND THE IPI PROJECT

This chapter deals with a description of the school district, students in the experimental and control groups, and the Individually Prescribed Instruction (IPI) Program.

A. Description of the School District and Research Population

Oakleaf Elementary School, one of twelve elementary schools in Baldwin-Whitehall, is the laboratory school experimenting in individualized instruction, operated jointly by the Learning Research and Development Center of the University of Pittsburgh and the Baldwin-Whitehall School District. The Baldwin-Whitehall School District is approximately ten miles from the city of Pittsburgh. The school district is comprised of Baldwin Borough, Baldwin Township, and Whitehall Borough. The area is classified as a suburban community with a vast majority of its working residents commuting to and from the city of Pittsburgh. The community from which Oakleaf draws its students is classified as a lower middle class socio-economic community.

The experimental group consisted of the fourth, fifth, and sixth grade students at Oakleaf (see Table 1). All of these students studied arithmetic under IPI for the first time during the school year 1964-65. During the school year 1963-64, the students were taught arithmetic in a conventional classroom setting.

The control, or comparison groups, consisted of fourth, fifth, and sixth grade students of MacAnnulty, McGibney, and Rolling Hills Elementary Schools in the Baldwin-Whitehall School District (see Tables 2, 3, 4, 5). All of these students studied arithmetic in a traditional or conventional classroom setting prior to and during the 1963-64 and 1964-65 school years. The IQ range and mean IQ of the different groups of all the schools are presented in the appendices.

TABLE 1

Number of Students at Each Ability Level in Grades 4, 5, and 6 in Oakleaf School (Experimental Group)

Ability Group	Fourth Grade (1 Section)	Fifth Grade (1 Section)	Sixth Grade (1 Section)	Total
Low	4	5	10	19
Average	10	10	5	25
High	9	6	7	22
Total	23	21	22	66

TABLE 2

Number of Students at Each Ability Level in Grades 4, 5, and 6 in MacAnnulty, McGibney, and Rolling Hills Schools (Total Control Group)

Ability Group	Fourth Grade (6 Sections)	Fifth Grade (7 Sections)	Sixth Grade (6 Sections)	Total (19 Sections)
Low	53	45	36	134
Average	32	48	50	130
High	38	41	56	135
Total	123	134	142	399

TABLE 3

Number of Students at Each Ability Level in Grades 4, 5, and 6 in MacAnnulty School (Control Group)

Ability Group	Fourth Grade (2 Sections)	Fifth Grade (3 Sections)	Sixth Grade (2 Sections)	Total (7 Sections)
Low	22	28	13	63
Average	11	19	17	47
High	20	21	23	64
Total	53	68	53	174

TABLE 4

Number of Students at Each Ability Level in Grades 4, 5, and 6 in McGibney School (Control Group

Ability Group	Fourth Grade (2 Sections)	Fifth Grade (2 Sections)	Sixth Grade (2 Sections)	Total (6 Sections)
Low	12	12	15	39
Average	14	16	17	47
High	12	10	15	37
Total	38	38	47	123

TABLE 5

Number of Students at Each Ability Level in Grades 4, 5, and 6 in Rolling Hills School (Control Group)

Ability Group	Fourth Grade (2 Sections)	Fifth Grade (2 Sections)	Sixth Grade (2 Sections)	Total (6 Sections)
Low	19	5	8	32
Average	7	13	16	36
High	6	10	18	34
Total	32	28	42	102

B. The Individually Prescribed Instruction Program (IPI)

1. Assumptions underlying the IPI program

The following assumptions were thought of to be guiding principles in an individualized instruction program.[1]

(a) One obvious way in which pupils differ is in the amount of time and practice that it takes to master given instructional objectives.

(b) One important aspect of providing for individual differences is to arrange conditions to that each student can work through the sequence of instructional units at his own pace and with the amount of practice he needs.

(c) If a school has the proper types of study materials, elementary school pupils working in a tutorial environment which emphasizes self-learning, can learn with a minimum amount of direct teacher instruction.

(d) In working through a sequence of instructional units, no pupil should be permitted to start work on a new unit until he has acquired a specified minimum degree of mastery of the material in the units identified as prerequisites to it.

(e) If pupils are to be permitted and encouraged to proceed at individual rates, it is important for both the individual pupil and for the teacher that the program provide for frequent evaluations of pupil progress which can provide a basis for the development of individual instructional prescriptions.

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[1] C. M. Lindvall and John O. Bolvin, "The Project for Individually Prescribed Instruction (Oakleaf Project)," University of Pittsburgh, Learning Research and Development Center, Mimeographed (working paper), 1965.

(f) Professionally trained teachers are employing themselves most productively when they are performing such tasks as instructing individual pupils or small groups, diagnosing pupil needs, and planning instructional programs rather than carrying out such clerical duties as keeping records, scoring tests, etc. The efficiency and economy of a school program can be increased by employing clerical help to relieve teachers of non-teaching duties.

(g) Each pupil can assume more responsibility for planning and carrying out his own program of study than is permitted in most classrooms.

(h) Learning can be enhanced, both for the tutor and the one being tutored, if pupils are permitted to help one another in certain ways.

2. The instructional materials in the IPI program

The mathematics curriculum at Oakleaf was developed by first defining a sequence of behavioral objectives for grades K through six and beyond. The materials used were selected on the basis of these objectives. The statement of the behavioral objective indicated the desired change in the child whenever he successfully completed a designated skill.

Specific criteria were used as guidelines in writing the behavioral objectives. Lindvall[1] suggested three:

(1) The objective should be stated in terms of the pupil.

(2) The objective should be stated in terms of observable behavior.

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[1] C. M. Lindvall, Testing and Evaluation: An Introduction, New York: Harcourt, Brace and World, Inc., 1961, Pp. 23-25.

(3) The statement of an objective should refer to the behavior or process and to the specific content to which this is to be applied.

After the objectives were identified, materials were selected to teach each behavioral objective. Much of the material was self-study in nature, that is, materials that a pupil could study or work by himself with a minimum of teacher direction. Worksheets from commercial arithmetic books and other work pages were used to teach the behavioral objectives in mathematics. Whenever a gap was located in the material, Learning Research and Development Center personnel or the teachers at Oakleaf would write work pages designed to teach this skill.

Many gaps were also eliminated by specific teacher instruction within the classroom. Hundreds of commercial pages were placed into specific units at varying levels of difficulty with the intent of matching work pages with a behavioral objective. There was no attempt to select any series of textbooks, workbooks, or any related material that would fit any particular curricular approach.

Although much of the material was self-study, it did not mean that there was no teacher-pupil interaction. Actually the total plan called for small group instruction, large group instruction, and individual tutoring by the teacher.

3. The instructional procedures of the IPI program

The amount of time spent on the Individually Prescribed Instruction Program (IPI) involved about forty-five minutes per day each for math and reading. For the remainder of the school day the students engaged in study under procedures followed in the other Baldwin-Whitehall schools.

An extensive placement testing program was initiated during the first month of school. This aided in placing a student where his capabilities made it possible to successfully begin the program. It was essential to the program that the individual differences could be identified and a prescription of work could be developed for each child. From the placement tests, the youngster was assigned a unit-level at which he began working.

The student was then given a diagnostic test (pretest) over the particular unit in order to determine the skills for which mastery or lack of mastery was indicated. If he fell below a particular score (85%) on the pretest he had a prescription written for him which decided how much and what skills had to be assigned. These pages of materials had been previously identified as to the skill they were to teach and the behavioral objective they would accomplish. This might have been enough material for a day, several days, or a week depending upon the ability of the student and the difficulty of the work.

A student then began working on his prescribed materials, usually studying by himself. This type of individual study was done at a desk in a study area seating 80 or 90 pupils. These areas are designated as the intermediate or primary learning centers. The student went to carts in which the materials of the curriculum were placed and collected work pages to complete his own prescription. In attendance at the carts was a teacher aide whose purpose was to help the student find the materials quickly and keep a constant inventory of the supply of materials.

After filling his prescription the student returned to the instructional center and began working. In this center there were two or three teachers who provided instructional assistance and three or four clerks to distribute materials and grade papers. When a student completed an assigned task he took it to one of the clerks or teachers who scored it immediately and recorded it on the student's prescription progress sheet. If he mastered the material on the work page he moved on to the next task. If not, he checked or corrected his work or sought assistance from one of the teachers.

In this manner most pupils were able to proceed through their study materials with a minimum of help from the teacher. If a teacher found a pupil who needed more help than she could give him in this large group situation, the pupil was directed to a small room where another teacher gave him individual help or would involve him in small group instruction. The constant recording of the students' scores on material developed into a progress chart for the student and indicated whether or not the skill sheets were adequate. It also enabled a judgment on what the student should do next. In the skill pages some were identified as "curriculum embedded" check tests. The student viewed these only as another work page but they helped determine more accurately whether or not he was ready for a posttest or should continue doing more work. After carefully reviewing a student's work, a teacher decided when it was time for the posttest in the unit in which the student was working.

When the student had to take a posttest he went to the test center, got his test, took it, and then returned it to the test center.

There an aide scored the test and returned it to the teacher along with all of the student's work in the unit. With the help of this information the teacher decided the next prescription.

IV. DESCRIPTION OF INSTRUMENTS USED AND DESIGN FOR DATA COLLECTION

The measures of achievement used in the study were the arithmetic subtests of the Metropolitan Achievement Test Battery and the Stanford Achievement Test Battery. The Metropolitan Test was used with the fourth and fifth grade students and the Stanford was used with the sixth grade students.[1]

The two subtests used from the Metropolitan Battery were arithmetic computation and problem solving. Data on the reliability of the tests of the Elementary and Intermediate Batteries of the Metropolitan Test are presented in Tables 6 and 7. The data consists of split-half coefficients computed separately for pupils in each of the several school systems and standard errors of measurement in raw score terms.

Data on the reliability of the tests in the Intermediate Battery of the Stanford Achievement Test are presented in Table 8. The table presents odd-even, split-half reliability coefficients, Kuder-Richardson reliability coefficients, and standard errors of measurement in terms of grade scores for each subject in the battery for a random sample of 1,000 pupils in the sixth grade.

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[1] The sixth grade students were given the revised (1963) Stanford Achievement Test in May, 1965. The test which they took in May, 1964, the results of which were used as the covariate in this study, was the 1953 edition of the Stanford. The two subtests in the 1953 edition are arithmetic computation and arithmetic reasoning. The 1963 edition has three subtests: arithmetic computation, arithmetic concepts, and arithmetic applications. An examination of test items indicates that the arithmetic reasoning subtest of the 1953 edition is similar to the arithmetic concepts subtest of the 1963 edition. For purposes of this study, these two subtests are assumed to be measuring the same types of abilities and, because of the general nature of the items involved, are referred to as measuring "arithmetic problem solving," which is the same name given to the second Metropolitan subtest.

TABLE 6

Reliability Coefficients and Standard Errors of Measurement for Elementary Subtests of the Metropolitan Achievement Test

	r_{11}		S.E. Meas.	
	Range	Mdn.	Range	Mdn.
Arithmetic Computation	.91 - .93	.92	1.8 - 2.3	1.9
Arithmetic Problem Solving	.86 - .91	.88	2.2 - 2.7	2.3

TABLE 7

Reliability Coefficients and Standard Errors of Measurement for Intermediate Subtests of the Metropolitan Achievement Test

	r_{11}		S.E. Meas.	
	Range	Mdn.	Range	Mdn.
Arithmetic Computation	.82 - .94	.88	2.1 - 2.7	2.4
Arithmetic Problem Solving	.90 - .95	.92	2.2 - 2.5	2.4

TABLE 8

Reliability Coefficients and Standard Errors of Measurement for Tests in Intermediate II Battery of the Stanford Achievement Test

Test	I1	$r_{KR_{20}}$	S.E. Meas.
Arithmetic Computation	.89	.87	5.5
Arithmetic Problem Solving	.85	.87	4.5

An analysis of covariance was used to test the significance of differences among the mean achievement scores for low, average, and high ability students when such scores were adjusted for differences among the groups in arithmetic achievement scores for the preceding year. The criterion measure was the achievement score (mean raw score) in May, 1965 and the covariate was the achievement score (mean raw score) in May, 1964. This type of analysis serves to test the significance of differences in gains in achievement during the 1964-65 school year.

In order to make more meaningful comparisons an analysis of covariance was performed on the data of each school within the control group rather than combining all the scores of the three schools for one analysis. This meant that Oakleaf and its IPI was compared separately to MacAnnulty, McGibney, and Rolling Hills Elementary Schools.

An analysis of covariance was performed on an IBM 7090 computer. The program was the BMD04V (Biomedical Computer Program). It was designed to compute the analysis of covariance information for one analysis of variance variable with multiple covariates and unequal treatment group size. The output included:

1. List of case numbers, data input, and group designation.
2. Variable means for each treatment group.
3. Sums of product matrices for Total, Treatment, and Error.
4. The inverse of the covariate matrices for Total, Treatment, and Error.
5. Analysis of covariance table with degrees of freedom, sum of squares, mean squares, and F-ratios.
6. Tables of regression coefficient, their standard errors and computed t-values with and without adjustment for groups.
7. Tables of adjusted means and their standard errors.

V. RESULTS OF THE STUDY

The data obtained in studying whether or not pupils of different ability levels differ in their progress and achievement under Individually Prescribed Instruction and how any such differences compare with those found in schools using more conventional programs of instruction are presented in seven sections:

A. Progress data for different ability students under Individually Prescribed Instruction.

B. Achievement in arithmetic computation by fourth grade students in the experimental and control groups.

C. Achievement in arithmetic problem solving by fourth grade students in the experimental and control groups.

D. Achievement in arithmetic computation by fifth grade students in the experimental and control groups.

E. Achievement in arithmetic problem solving by fifth grade students in the experimental and control groups.

F. Achievement in arithmetic computation by sixth grade students in the experimental and control groups.

G. Achievement in arithmetic problem solving by sixth grade students in the experimental and control groups.

Each of the sections, B through G, provides the variable means and the adjusted means for the high, average, and low experimental and control groups. Each section also includes an analysis of covariance summary providing the source of variation, sum of squares, degrees of freedom, mean square, and the significance or non-significance of F.

A. Progress Data for Different Ability Students Under Individually Prescribed Instruction

One basic type of data that is meaningful in examining the effectiveness of the IPI project with students of different ability levels is that pertaining to the amount of content covered during the school year. Are there differences in the rate for mastering arithmetic skills of different ability level students? Do brighter students master more units during a given year than the average or slow students? Do the slow students show an appreciable amount of content mastered? Data with respect to such questions is presented in Table 9.

The table gives mean scores for the fourth, fifth, and sixth grade high, average, and low ability groups. The scores for each student within the groups are given in the appendices.

School was in session for 185 days in 1964-65. The number of skills represents the number of behavioral objectives a student successfully mastered by working lesson pages which were designed to teach the skills. The number of units involves those which a student successfully mastered by doing the necessary lesson pages for the many skills within a unit. As was previously mentioned, a unit consisted of many skills.

In some cases a student did not have to work on any lesson pages in order to master a particular unit. If the student received a high pretest score on a unit, the unit was considered mastered and the student was assigned work in another unit. This prevented the overlap of teaching something previously learned by the student. The last category in Table 9 (Total Units) gives the sum of the units actually worked in and mastered and units which were mastered by a high pretest score.

TABLE 9

Mean Values for Days Attendance, Number of Skills and Units Mastered, and Number of Units which were Pretested Out for Fourth, Fifth, and Sixth Grade Students Studying Under IPI

Ability Group	Days in Attendance	Skills Mastered	Units Mastered	Assessed Units Mastered	Total Units
4th High	181.06	25.33	9.00	6.22	15.22
Aver	179.85	20.60	6.90	6.30	13.20
Low	179.38	20.75	8.00	4.75	12.75
5th High	180.42	24.00	8.17	5.83	14.00
Aver	180.90	27.10	9.10	6.10	15.20
Low	180.40	19.60	7.40	5.40	12.80
6th High	181.71	33.43	9.14	7.14	16.29
Aver	184.1	36.8	9	7.4	16.40
Low	181.35	27.5	8.7	4.8	13.50

In observing Table 9 it was expected that the high ability group in each grade would show mastery of a greater number of units than the average group and that the average group would have greater mastery than the low group. Generally speaking, this tended to be true, but some inconsistency was revealed.

The fourth grade recorded some inconsistency in skills and units. The low group had higher mastery mean measures than the average group. However, in total units the average group reported a higher mastery. Another inconsistency was in units assessed as mastered due to a high pretest score. The average group score was 6.30 while the high group was 6.22. However, again in total units the high group reported a higher measure than the average group.

In fifth grade the average group recorded higher values than the high and low groups in all categories. No inconsistency is shown between the high and low groups, with the high group having higher values. However, the actual differences do not seem to be that large.

Sixth grade shows the average group measure higher than the high group in skills, units pretested out of, and total units. No inconsistency is reported between the high and low group and the average and low group. The average measures of the sixth grade groups, except for a few cases, are higher than the values for the fourth and fifth grade.

Despite these noted inconsistencies, it can be said that, in general, the higher ability students tend to cover more work than the lower ability students.

B. Achievement in Arithmetic Computation by Fourth Grade Students in the Experimental and Control Groups

The first hypothesis deals with the mean achievement scores in arithmetic computation for the fourth grade high, average, and low ability students of Oakleaf Elementary School. Is there a difference in the arithmetic achievement for the three ability groups during the year in which the students studied under Individually Prescribed Instruction? This was investigated by examining their scores on the Metropolitan Achievement Test given in May, 1965, at the end of their first year of IPI. However, conclusions to be drawn from such scores must take into account the math ability that these students had at the beginning of the year. In order to do this an analysis of covariance was used.

In Table 10 the mean values under the category of 1964 (covariate) were based on the scores made by fourth grade students at the end of the school year 1963-64. The actual testing time was in May, 1964. The students had been taught mathematics in a conventional classroom setting. The mean values for 1965 were obtained from the same students after the school year 1964-65. The actual testing time was in May, 1965. During this school year the students were taught mathematics under the Individually Prescribed Instruction program.

The adjusted mean values represent the means in the 1965 testing, adjusted for differences on the means for the 1964 testing (the "pretest" measures). The adjustment permits us to compare the three groups by using the adjusted means as measures of the effect of the one year's experience that took place between the 1964 and 1965 testing.

Table 11 provides an analysis of covariance summary for the data that are represented in Table 10. The F value of .498 was not significant and the first hypothesis was not rejected. The arithmetic computation scores for high, average, and low ability fourth grade students at Oakleaf do not differ significantly. This implies that the IPI program did not differentially affect achievement of the three ability groups in the fourth grade.

TABLE 10

Means for 1964 and 1965 Achievement Scores in Computation and Adjusted Treatment Means for Fourth Grade Oakleaf Students

Treatment Group	1964	1965	Adjusted Mean
High	33.111	32.778	31.406
Average	31.000	33.100	32.258
Low	27.500	28.000	30.694

TABLE 11

Summary of Analysis of Covariance Table for Achievement Scores in Computation for Fourth Grade Oakleaf Students

Source of Variation	Sum of Squares	d.f.	Mean Square	F
Treatment	25.557	2	12.778	.498*
Error	487.426	19	25.654	
Total	512.984	21		

* not significant

The second hypothesis deals with the mean achievement scores in arithmetic computation for the fourth grade students at MacAnnulty Elementary School which was one of the three schools compared to Oakleaf and its IPI program. Would the different ability groups show differences in achievement in a conventional classroom setting comparable to that under the IPI program? Can significant differences be found among high, average, and low ability students under conventional instruction?

In attempting to answer these questions the scores in arithmetic computation on the Metropolitan Achievement Test given in May, 1965 were examined. Again, the math ability of the students prior to that date had to be taken into account. This was done by using the scores in May, 1964 as the covariate and the scores in May, 1965 as the experimental measure in an analysis of covariance. It should be remembered that the instruction prior to both testings in all three control schools took place in a conventional classroom setting.

The variable means and adjusted means in arithmetic computation for MacAnnulty's fourth grade are given in Table 12.[1] The summary of the analysis of covariance for the same data is given in Table 13 with the F of 12.186 being significant at the .01 level. The second hypothesis was rejected. This significance may suggest that the instruction at MacAnnulty in the fourth grade operated differentially with certain ability level students.

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[1] It will be noted that in the case of many of the sets of test data reported in this chapter, such as those shown in Table 12, the students in the control schools show a greater gain than those at Oakleaf. On the basis of a careful analysis of the IPI arithmetic content and the items on the standardized test, the staff of the IPI project feels that a major reason for the small increase in test scores for Oakleaf students is that these students, at certain levels, are studying many topics that are not covered by the standardized tests and in this way are making gains in achievement not measured by these instruments.

TABLE 12

Means for 1964 and 1965 Achievement Scores in Computation and Adjusted Treatment Means for Fourth Grade MacAnnulty Students

Treatment Group	1964	1965	Adjusted Mean
High	31.950	40.350	40.448
Average	28.000	34.000	33.914
Low	28.864	31.091	31.045

TABLE 13

Summary of Analysis of Covariance Table for Achievement Scores in Computation for Fourth Grade MacAnnulty Students

Source of Variation	Sum of Squares	d.f.	Mean Square	F
Treatment	923.572	2	461.786	12.186*
Error	1856.909	49	37.896	
Total	2780.481	51		

* significant at the .01 level

Hypotheses three and four are similar to the second hypothesis with the exception of the school involved. The third hypothesis deals with data from McGibney School and the fourth with data from Rolling Hills School. The same questions can be asked here as were asked concerning MacAnnulty Elementary School in the second hypothesis. Can significant differences in the achievement scores in arithmetic computation be found among high, average, and low ability students under conventional instruction in McGibney and Rolling Hills Schools? The variable means and adjusted means in arithmetic computation for McGibney's fourth grade group are given in Table 14 and the summary of the analysis of covariance is presented in Table 15. The F of 4.852 was significant at the .05 level and the third hypothesis was rejected.

The variable means, adjusted means, and analysis of covariance summary for Rolling Hills fourth grade group are presented in Tables 16 and 17. The F of 1.201 was not significant and the fourth hypothesis was not rejected.

In summarizing section B, Oakleaf's fourth grade group under IPI showed no significant differences among high, average, and low ability students. However, the analysis of data for two of three schools (MacAnnulty and McGibney) in the control group did report a significant difference. The scores used in the above analysis were those in arithmetic computation. The next section deals with achievement scores in problem solving for the same students.

TABLE 14

Means for 1964 and 1965 Achievement Scores in Computation and Adjusted Treatment Means for Fourth Grade McGibney Students

Treatment Group	1964	1965	Adjusted Mean
High	28.583	41.500	39.992
Average	26.357	36.214	35.897
Low	22.250	37.167	39.045

TABLE 15

Summary of Analysis of Covariance Table for Achievement Scores in Computation for Fourth Grade McGibney Students

Source of Variation	Sum of Squares	d.f.	Mean Square	F
Treatment	121.327	2	60.663	4.852*
Error	425.074	34	12.502	
Total	546.401	36		

* significant at the .05 level

TABLE 16

Means for 1964 and 1965 Achievement Scores in Computation and Adjusted Treatment Means for Fourth Grade Rolling Hills Students

Treatment Group	1964	1965	Adjusted Mean
High	28.667	42.833	41.220
Average	31.571	43.000	38.726
Low	24.632	35.421	37.505

TABLE 17

Summary of Analysis of Covariance Table for Achievement Scores in Computation for Fourth Grade Rolling Hills Students

Source of Variation	Sum of Squares	d.f.	Mean Square	F
Treatment	58.877	2	29.438	1.201*
Error	686.170	28	24.506	
Total	745.047	30		

* not significant

C. Achievement in Problem Solving by Fourth Grade Students in the Experimental and Control Groups

Section B dealt with the achievement scores in arithmetic computation on the Metropolitan Achievement Test for the fourth grade students. This section presents an analysis of the scores in arithmetic problem solving for the same students. Questions which were asked in Section B can also be asked here. Hypothesis five states: There is no significant difference among the mean achievement scores in arithmetic problem solving on the Metropolitan Achievement Test given in May, 1965 for low, average, and high ability fourth grade students at Oakleaf under IPI when the achievement scores from May, 1964 are used as covariates.

The variable means and adjusted means in arithmetic problem solving for Oakleaf's fourth grade groups are given in Table 18. The summary of the analysis of covariance table is presented in Table 19 with the F of 1.504 being not significant. Hypothesis five was not rejected.

TABLE 18

Means for 1964 and 1965 Achievement Scores in Problem Solving and Adjusted Treatment Means for Fourth Grade Oakleaf Students

Treatment Group	1964	1965	Adjusted Mean
High	24.000	26.111	24.317
Average	21.200	24.200	25.224
Low	20.750	20.000	21.477

TABLE 19

Summary of Analysis of Covariance Table for Achievement Scores in Problem Solving for Fourth Grade Oakleaf Students

Source of Variation	Sum of Squares	d.f.	Mean Square	F
Treatment	40.156	2	20.178	1.504*
Error	253.617	19	13.348	
Total	293.773	21		

* not significant

Hypotheses six, seven, and eight deal with the question of whether or not any significant differences in problem solving in the fourth grade can be found with comparable groups under conventional instruction. The variable means and adjusted means in arithmetic problem solving for MacAnnulty's fourth grade group are presented in Table 20. The summary of the analysis of covariance table is given in Table 21 with the F of 7.296 being significant at the .01 level. Hypothesis six was rejected. This significance, like that in arithmetic computation for MacAnnulty School, may again suggest that the instruction at MacAnnulty in the fourth grade operated differentially with certain ability level students.

TABLE 20

Means for 1964 and 1965 Achievement Scores in Problem Solving and Adjusted Treatment Means for Fourth Grade MacAnnulty Students

Treatment Group	1964	1965	Adjusted Mean
High	24.900	30.000	27.881
Average	21.000	25.818	26.071
Low	18.454	19.591	21.391

TABLE 21

Summary of Analysis of Covariance Table for Achievement Scores in Problem Solving for Fourth Grade MacAnnulty Students

Source of Variation	Sum of Squares	d.f.	Mean Square	F
Treatment	372.812	2	186.406	7.296*
Error	1251.834	49	25.548	
Total	1624.646	51		

* significant at the .01 level

The data in problem solving for the other two control schools (McGibney and Rolling Hills) are presented in Tables 22-25. Both schools reported non-significant F's in the analysis of covariance. Hypotheses seven and eight were not rejected.

In summarizing Section C, Oakleaf's fourth grade group under IPI again showed no significant difference among high, average, and low ability students in their achievement in arithmetic problem solving. The analysis of data for one of the control schools (MacAnnulty) did indicate a significant difference while the data for the other two schools (McGibney and Rolling Hills) did not indicate any significant difference.

TABLE 22

Means for 1964 and 1965 Achievement Scores in Problem Solving and Adjusted Treatment Means for Fourth Grade McGibney Students

Treatment Group	1964	1965	Adjusted Mean
High	22.167	30.333	28.159
Average	17.929	26.357	26.512
Low	14.583	22.833	24.827

TABLE 23

Summary of Analysis of Covariance Table for Achievement Scores in Problem Solving for Fourth Grade McGibney Students

Source of Variation	Sum of Squares	d.f.	Mean Square	F
Treatment	49.435	2	24.718	2.397*
Error	350.632	34	10.313	
Total	400.067	36		

* not significant

TABLE 24

Means for 1964 and 1965 Achievement Scores in Problem Solving and Adjusted Treatment Means for Fourth Grade Rolling Hills Students

Treatment Group	1964	1965	Adjusted Mean
High	25.500	30.500	25.638
Average	21.571	28.429	26.766
Low	16.895	22.790	24.937

TABLE 25

Summary of Analysis of Covariance Table for Achievement Scores in Problem Solving for Fourth Grade Rolling Hills Students

Source of Variation	Sum of Squares	d.f.	Mean Square	F
Treatment	15.819	2	7.909	.786*
Error	281.819	28	10.065	
Total	297.638	30		

* not significant

D. Achievement in Arithmetic Computation by Fifth Grade Students in the Experimental and Control Groups

Section D deals with the achievement scores in arithmetic computation on the Metropolitan Achievement Test for the fifth grade students in the experimental and control groups. The data were analyzed in the same manner as the fourth grade students' scores. This enabled the researcher to compare high, average, and low ability students within a particular grade and also make a comparison between different grade levels.

Hypothesis nine states: There is no significant difference among the mean achievement scores in arithmetic computation on the Metropolitan Achievement Test given in May, 1965 for low, average, and high ability fifth grade students of Oakleaf School under IPI when the achievement scores from May, 1964 are used as covariates. The means and adjusted treatment means for Oakleaf's fifth grade group are presented in Table 26. The reason for the large differences between the mean scores in 1964 and 1965 is because the Metropolitan Elementary Test Battery was used in the third and fourth grade and the Intermediate Test Battery was used in the fifth and sixth grade. The values for these fifth grade students, therefore, were received from two different batteries whereas the data for the fourth grade students in the experimental and control groups were received from one test battery. The differences are more noticeable in arithmetic computation than in problem solving. A similar instance arose with the sixth grade students. In this case, however, it was not a difference in test battery but rather a revision of the battery that was used in the previous year.

The summary of the analysis of covariance is presented in Table 27. The data for the students under IPI again reported no significant difference among high, average, and low ability students. Hypothesis nine was not rejected.

TABLE 26

Means for 1964 and 1965 Achievement Scores in Computation and Adjusted Treatment Means for Fifth Grade Oakleaf Students

Treatment Group	1964	1965	Adjusted Mean
High	40.167	19.333	18.542
Average	40.200	18.600	17.789
Low	34.200	10.400	12.971

TABLE 27

Summary of Analysis of Covariance Table for Achievement Scores in Computation for Fifth Grade Oakleaf Students

Source of Variation	Sum of Squares	d.f.	Mean Square	F
Treatment	77.417	2	38.708	1.613*
Error	407.928	17	23.996	
Total	485.345	19		

* not significant

Hypotheses ten, eleven, and twelve deal with the same statement as hypothesis nine for the fifth grade students in MacAnnulty, McGibney, and Rolling Hills, respectively.

The means and adjusted treatment means for MacAnnulty are presented in Table 28. The analysis of covariance summary is given in Table 29. The F of 3.111 was significant at the .10 level. Hypothesis ten was rejected.

TABLE 28

Means for 1964 and 1965 Achievement Scores in Computation and Adjusted Treatment Means for Fifth Grade MacAnnulty Students

Treatment Group	1964	1965	Adjusted Mean
High	39.048	27.190	23.788
Average	34.842	21.737	21.512
Low	30.964	17.179	19.883

TABLE 29

Summary of Analysis of Covariance Table for Achievement Scores in Computation for Fifth Grade MacAnnulty Students

Source of Variation	Sum of Squares	d.f.	Mean Square	F
Treatment	141.392	2	70.696	3.111*
Error	1454.147	64	22.721	
Total	1595.539	66		

* significant at the .10 level

The means and adjusted treatment means for McGibney's fifth grade group are presented in Table 30. The analysis of covariance summary is reported in Table 31 with the F of 4.781 being significant at the .05 level. Hypothesis eleven was rejected.

TABLE 30

Means for 1964 and 1965 Achievement Scores in Computation and Adjusted Treatment Means for Fifth Grade McGibney Students

Treatment Group	1964	1965	Adjusted Mean
High	43.500	31.800	27.734
Average	40.875	24.812	23.583
Low	35.083	18.083	23.112

TABLE 31

Summary of Analysis of Covariance Table for Achievement Scores in Computation for Fifth Grade McGibney Students

Source of Variation	Sum of Squares	d.f.	Mean Square	F
Treatment	113.603	2	56.801	4.781*
Error	403.935	34	11.880	
Total	517.538	36		

* significant at the .05 level

The means, adjusted treatment means, and covariance summary for Rolling Hills School are presented in Tables 32 and 33. Again, Rolling Hills reported no significant difference among its three ability groups and hypothesis twelve was not rejected.

TABLE 32

Means for 1964 and 1965 Achievement Scores in Computation and Adjusted Treatment Means for Fifth Grade Rolling Hills Students

Treatment Group	1964	1965	Adjusted Mean
High	39.200	33.100	31.152
Average	35.923	29.692	30.554
Low	35.000	24.600	26.254

TABLE 33

Summary of Analysis of Covariance Table for Achievement Scores in Computation for Fifth Grade Rolling Hills Students

Source of Variation	Sum of Squares	d.f.	Mean Square	F
Treatment	83.628	2	41.814	2.867*
Error	350.002	24	14.583	
Total	433.630	26		

* not significant

In summarizing Section D, Oakleaf's fifth grade students under IPI did not show any significant difference among its high, average, and low ability groups in achievement in arithmetic computation. The analysis of data for two of the control schools (MacAnnulty and McGibney) indicated a significant difference among their ability groups and the data for the third school (Rolling Hills) indicated no significant difference.

E. Achievement in Arithmetic Problem Solving by Fifth Grade Students in the Experimental and Control Groups

Section E pertains to the achievement scores in arithmetic problem solving on the Metropolitan Achievement Test for the experimental and control groups. Hypotheses thirteen, fourteen, fifteen, and sixteen correspond to this section.

Hypothesis thirteen states: There is no significant difference among the achievement scores in arithmetic problem solving for high, average, and low ability fifth grade students at Oakleaf School under IPI. The means and adjusted treatment means for this group are presented in Table 34. A non-significant F of .296 is reported in the covariance summary in Table 35 which seems to be supportive evidence that the IPI program did not differentially affect achievement of the three ability groups in the fifth grade. Hypothesis thirteen was not rejected.

TABLE 34

Means for 1964 and 1965 Achievement Scores in Problem Solving and Adjusted Treatment Means for Fifth Grade Oakleaf Students

Treatment Group	1964	1965	Adjusted Mean
High	31.000	27.333	24.978
Average	30.100	27.300	26.030
Low	24.600	18.600	23.966

TABLE 35

Summary of Analysis of Covariance Table for Achievement Scores in Problem Solving for Fifth Grade Oakleaf Students

Source of Variation	Sum of Squares	d.f.	Mean Square	F
Treatment	11.505	2	5.752	.296*
Error	329.888	17	19.405	
Total	341.393	19		

* not significant

Hypotheses fourteen, fifteen, and sixteen deal with whether or not there is a significant difference in the achievement scores in problem solving for the fifth grade students at MacAnnulty, McGibney, and Rolling Hills Schools. All three schools in the control group reported non-significant F's. All three hypotheses were not rejected. The fifth grade problem solving and sixth grade computation are the only categories where all schools (experimental and control) reported non-significant F's.

The data for MacAnnulty is presented in Tables 36 and 37 with an F value of .796. The data for McGibney and Rolling Hills is in Tables 38-41 with the respective F values of 2.765 and .195.

TABLE 36

Means of 1964 and 1965 Achievement Scores in Problem Solving and Adjusted Treatment Means for Fifth Grade MacAnnulty Students

Treatment Group	1964	1965	Adjusted Mean
High	30.952	31.524	26.367
Average	25.474	25.105	24.916
Low	20.857	19.929	23.925

TABLE 37

Summary of Analysis of Covariance Table for Achievement Scores in Problem Solving for Fifth Grade MacAnnulty Students

Source of Variation	Sum of Squares	d.f.	Mean Square	F
Treatment	44.430	2	21.215	.796*
Error	1786.078	64	27.908	
Total	1830.508	66		

* not significant

TABLE 38

Means for 1964 and 1965 Achievement Scores in Problem Solving and Adjusted Treatment Means for Fifth Grade McGibney Students

Treatment Group	1964	1965	Adjusted Mean
High	32.100	33.100	28.441
Average	28.000	26.625	26.003
Low	22.583	17.667	22.378

TABLE 39

Summary of Analysis of Covariance Table for Achievement Scores in Problem Solving for Fifth Grade McGibney Students

Source of Variation	Sum of Squares	d.f.	Mean Square	F
Treatment	132.147	2	66.073	2.765*
Error	812.458	34	23.896	
Total	944.605	36		

* not significant

TABLE 40

Means for 1964 and 1965 Achievement Scores in Problem Solving and Adjusted Treatment Means for Fifth Grade Rolling Hills Students

Treatment Group	1964	1965	Adjusted Mean
High	30.000	33.500	29.954
Average	26.923	30.923	31.294
Low	22.400	24.400	30.528

TABLE 41

Summary of Analysis of Covariance Table for Achievement Scores in Problem Solving for Fifth Grade Rolling Hills Students

Source of Variation	Sum of Squares	d.f.	Mean Square	F
Treatment	9.734	2	4.867	.195*
Error	598.394	24	24.933	
Total	608.128	26		

* not significant

In summarizing Section E, the analysis of data for all schools in the experimental and control groups indicated no significant difference in the achievement scores in problem solving for high, average, and low ability fifth grade students.

F. Achievement in Arithmetic Computation by Sixth Grade Students in the Experimental and Control Groups

Section F deals with the achievement scores in arithmetic computation on the Stanford Achievement Test for the sixth grade students in the experimental and control groups. These students were tested on the Stanford when they were in the fifth grade. The fifth grade scores were the covariates in the analysis of covariance with the criterion scores being the scores received from the same students in the sixth grade.

Hypothesis seventeen is concerned whether or not there is a significant difference among the achievement scores in arithmetic computation for high, average, and low ability sixth grade students under IPI at Oakleaf. The means and adjusted treatment means for Oakleaf's sixth grade group are presented in Table 42. The covariance summary is presented in Table 43 with an F of 1.459 which was not significant. Hypothesis seventeen was not rejected.

TABLE 42

Means for 1964 and 1965 Achievement Scores in Computation and Adjusted Treatment Means for Sixth Grade Oakleaf Students

Treatment Group	1964	1965	Adjusted Mean
High	30.143	25.571	22.060
Average	30.000	20.200	17.795
Low	22.800	15.700	18.661

TABLE 43

Summary of Analysis of Covariance Table for Achievement Scores in Computation for Sixth Grade Oakleaf Students

Source of Variation	Sum of Squares	d.f.	Mean Square	F
Treatment	62.642	2	31.321	1.459*
Error	386.489	18	21.472	
Total	449.131	20		

* not significant

As mentioned earlier, the analysis for all schools in Section F indicated non-significant F's. Hypotheses eighteen, nineteen, and twenty are concerned with whether or not a significant difference existed among different ability students in their achievement in computation in the control schools. All three hypotheses were not rejected.

The data for MacAnnulty's sixth grade group are presented in Tables 44 and 45. An F value of .026 was reported which was the lowest non-significant F recorded by any school group.

TABLE 44

Means for 1964 and 1965 Achievement Scores in Computation and Adjusted Treatment Means for Sixth Grade MacAnnulty Students

Treatment Group	1964	1965	Adjusted Mean
High	29.348	27.261	25.101
Average	25.294	23.412	24.838
Low	24.692	23.308	25.266

TABLE 45

Summary of Analysis of Covariance Table for Achievement Scores in Computation for Sixth Grade MacAnnulty Students

Source of Variation	Sum of Squares	d.f.	Mean Square	F
Treatment	1.425	2	.712	.026*
Error	1330.100	49	27.145	
Total	1331.525	51		

* not significant

The data for McGibney are presented in Tables 46 and 47 with a recorded F of 1.182. Rolling Hills' sixth grade data are presented in Tables 48 and 49 with a non-significant F of .371.

TABLE 46

Means for 1964 and 1965 Achievement Scores in Computation and Adjusted Treatment Means for Sixth Grade McGibney Students

Treatment Group	1964	1965	Adjusted Mean
High	25.867	29.467	27.881
Average	25.471	27.588	26.409
Low	21.467	22.133	25.056

TABLE 47

Summary of Analysis of Covariance Table for Achievement Scores in Computation for Sixth Grade McGibney Students

Source of Variation	Sum of Squares	d.f.	Mean Square	F
Treatment	50.904	2	25.452	1.182*
Error	926.243	43	21.540	
Total	977.147	45		

* not significant

TABLE 48

Means for 1964 and 1965 Achievement Scores in Computation and Adjusted Treatment Means for Sixth Grade Rolling Hills Students

Treatment Group	1964	1965	Adjusted Mean
High	31.000	31.611	29.234
Average	24.375	28.250	29.099
Low	18.625	24.000	27.649

TABLE 49

Summary of Analysis of Covariance Table for Achievement Scores in Computation for Sixth Grade Rolling Hills Students

Source of Variation	Sum of Squares	d.f.	Mean Square	F
Treatment	9.461	2	4.730	.371*
Error	484.050	38	12.738	
Total	493.511	40		

* not significant

G. Achievement in Arithmetic Problem Solving by Sixth Grade Students in the Experimental and Control Groups

Section G deals with the scores in arithmetic problem solving on the Stanford Achievement Test for sixth grade students in the experimental and control groups. Hypothesis twenty-one is concerned with whether or not there is a significant difference in the problem solving scores among different ability students at Oakleaf under IPI. The means and adjusted treatment means are given in Table 50. The covariance summary is presented in Table 51 with a non-significant F of .839. Hypothesis twenty-one was not rejected.

TABLE 50

Means for 1964 and 1965 Achievement Scores in Problem Solving and Adjusted Treatment Means for Sixth Grade Oakleaf Students

Treatment Group	1964	1965	Adjusted Mean
High	35.000	23.000	20.878
Average	36.400	21.000	17.994
Low	26.900	16.700	19.688

TABLE 51

Summary of Analysis of Covariance Table for Achievement Scores in Problem Solving for Sixth Grade Oakleaf Students

Source of Variation	Sum of Squares	d.f.	Mean Square	F
Treatment	24.112	2	12.056	.839*
Error	258.552	18	14.364	
Total	282.664	20		

* not significant

The last three hypotheses (twenty-two, twenty-three and twenty-four) deal with the same question as hypothesis twenty-one with reference to the students in the control groups. The data for MacAnnulty School are given in Tables 52 and 53. The F of 4.482 was significant at the .05 level. Hypothesis twenty-two was rejected.

TABLE 52

Means for 1964 and 1965 Achievement Scores in Problem Solving and Adjusted Treatment Means for Sixth Grade MacAnnulty Students

Treatment Group	1964	1965	Adjusted Mean
High	35.435	24.826	23.269
Average	32.118	19.647	19.749
Low	27.077	17.231	19.853

TABLE 53

Summary of Analysis of Covariance Table for Achievement Scores in Problem Solving for Sixth Grade MacAnnulty Students

Source of Variation	Sum of Squares	d.f.	Mean Square	F
Treatment	130.785	2	65.392	4.482*
Error	714.865	49	14.589	
Total	845.650	51		

* significant at the .05 level

The analysis of data for the other two schools, McGibney and Rolling Hills, reported non-significant F values. The data for McGibney are presented in Tables 54 and 55 with an F of .756. Rolling Hills' data are given in Tables 56 and 57 with an F value of 1.474. Hypotheses twenty-three and twenty-four were not rejected. A summary of the F values for all schools for arithmetic computation and problem solving is presented in Tables 58 and 59.

TABLE 54

Means for 1964 and 1965 Achievement Scores in Problem Solving and Adjusted Treatment Means for Sixth Grade McGibney Students

Treatment Group	1964	1965	Adjusted Mean
High	33.667	24.400	21.323
Average	30.412	20.824	19.893
Low	22.733	15.467	19.598

TABLE 55

Summary of Analysis of Covariance Table for Achievement Scores in Problem Solving for Sixth Grade McGibney Students

Source of Variation	Sum of Squares	d.f.	Mean Square	F
Treatment	18.668	2	9.334	.756*
Error	530.878	43	12.346	
Total	549.546	45		

* not significant

TABLE 56

Means for 1964 and 1965 Achievement Scores in Problem Solving and Adjusted Treatment Means for Sixth Grade Rolling Hills Students

Treatment Group	1964	1965	Adjusted Mean
High	37.833	26.389	23.693
Average	33.688	22.312	22.725
Low	27.250	19.625	24.865

TABLE 57

Summary of Analysis of Covariance Table for Achievement Scores in Problem Solving for Sixth Grade Rolling Hills Students

Source of Variation	Sum of Squares	d.f.	Mean Square	F
Treatment	22.770	2	11.385	1.474*
Error	293.555	38	7.725	
Total	316.325	40		

* not significant

In summarizing Section G, the data for the sixth grade students under IPI at Oakleaf indicated no significant difference in problem solving scores among high, average, and low ability students. The data for one of the control schools (MacAnnulty) indicated a significant difference while that for McGibney and Rolling Hills recorded non-significant F values.

In summary, the progress data of the different ability groups under IPI indicated that the higher ability students tended to do more work than the lower ability students. Even though some inconsistencies were reported, the numerical differences in these cases were very small and of little significance. In regard to whether or not the IPI program operated differentially on different ability groups, no significant differences were reported among high, average, and low ability fourth, fifth, and sixth grade students in arithmetic computation or problem solving scores whenever their pretest performance was taken into consideration.

TABLE 58

F-Values in Arithmetic Computation for the Experimental and Control Schools

School	Fourth Grade	Fifth Grade	Sixth Grade
Oakleaf	.498	1.613	1.459
MacAnnulty	12.186*	3.11 ***	.026
McGibney	4.852**	4.781**	1.182
Rolling Hills	1.201	2.867	.371

* significant at the .01 level

** significant at the .05 level

*** significant at the .10 level

TABLE 59

F-Values in Arithmetic Problem Solving for the Experimental and Control Schools

School	Fourth Grade	Fifth Grade	Sixth Grade
Oakleaf	1.504	.296	.839
MacAnnulty	7.296*	.796	4.482**
McGibney	2.397	2.765	.756
Rolling Hills	.786	.195	1.474

* significant at the .01 level

** significant at the .05 level

*** significant at the .10 level

VI. FINDINGS, CONCLUSIONS, AND RECOMMENDATIONS FOR FURTHER RESEARCH

The study proposed to answer the following question: Is there a difference among pupils at different ability levels in their progress and achievement under Individually Prescribed Instruction and how do any such differences compare to those found in schools using more conventional programs of instruction?

A. Findings

1. Progress Data for Pupils at Different Ability Levels Under Individually Prescribed Instruction.

In general, the higher ability groups tended to do more work than the lower ability groups. Although there was some inconsistency within each grade, the numerical differences were not large enough to be of any practical significance. The most frequent inconsistency was that of the average group scoring better than the high group. However, the size of such differences was very small.

The progress data indicated that the higher ability students mastered more arithmetic skills and units than the lower ability students. It was hoped that the IPI program would not discriminate against pupils at any level of aptitude and that each of the ability groups would show definite progress in arithmetic. The data seemed to support this along with showing that the more able students did cover more material during the course of the school year.

2. Achievement in Arithmetic Computation by Fourth Grade Students in the Experimental and Control Groups.

There was no significant difference among high, average, and low ability fourth grade Oakleaf students in arithmetic computation scores whenever the pretest performance was taken into account. This is supportive evidence that the Individually Prescribed Instruction Program at Oakleaf Elementary School did not operate differentially for any ability group in the fourth grade.

A significant difference in the computation scores was reported in two of the control schools. The data for both MacAnnulty and McGibney Elementary Schools indicated significant differences in achievement for different ability students. The analysis of data for the third control school, Rolling Hills, indicated no significant differences in the scores of its three ability groups.

3. Achievement Scores in Arithmetic Problem Solving by Fourth Grade Students in the Experimental and Control Groups.

There was no significant difference among high, average, and low ability fourth grade Oakleaf students in the arithmetic problem solving scores whenever the pretest performance was taken into account. This is further supportive evidence that the IPI program did not differentially affect achievement of the three ability groups in the fourth grade.

The data for one of the control schools, MacAnnulty, indicated a significant difference in the problem solving scores of the different ability fourth grade students, but the F values which were reported for McGibney and Rolling Hills Schools indicated no significant difference.

4. Achievement in Arithmetic Computation by Fifth Grade Students in the Experimental and Control Groups.

There was no significant difference among high, average, and low ability fifth grade Oakleaf students in the arithmetic computation scores whenever the pretest performance was taken into account. These findings correspond to those found in the fourth grade.

Once again the analysis of data for two of the control schools, MacAnnulty and McGibney, did indicate significant differences in the computation scores of their students under conventional instruction, and the data for Rolling Hills indicated no significant difference in the scores for their fifth grade students.

5. Achievement in Arithmetic Problem Solving by Fifth Grade Students in the Experimental and Control Groups.

There was no significant difference among high, average, and low ability fifth grade Oakleaf students in arithmetic problem solving scores whenever the pretest performance was taken into account. This again corresponds to the findings reported for the fourth grade students at Oakleaf. This evidence suggests that when achievement is measured by a standardized test the IPI program has a similar impact on the three ability levels: high, average, and low.

The data for each of the three control schools also indicated no significant difference in the problem solving scores of their ability groups.

6. Achievement in Arithmetic Computation by Sixth Grade Students in the Experimental and Control Groups.

There was no significant difference among high, average, and low ability sixth grade Oakleaf students in arithmetic computation scores whenever the pretest performance was taken into account. This result is comparable to that found for the fourth and fifth grades at Oakleaf.

The data for each of the three control schools, MacAnnulty, McGibney, and Rolling Hills, indicated no significant differences. All schools, experimental and control, indicated no significant differences among the fifth grade ability groups using problem solving scores and among the sixth grade ability groups using computation scores.

7. Achievement in Arithmetic Problem Solving by Sixth Grade Students in the Experimental and Control Groups.

There was no significant difference among high, average, and low ability sixth grade Oakleaf students in the arithmetic problem solving scores whenever the pretest performance was taken into account. All three grades under IPI thus reported no significant difference among their ability groups whenever computation or problem solving scores were used in the analysis.

The data for MacAnnulty indicated a significant difference in the problem solving scores for its sixth grade students but the data for McGibney and Rolling Hills reported F values which were not significant.

B. Conclusions

This has been a study pertaining to the effect of the Individually Prescribed Instruction program on different ability students at Oakleaf Elementary School in the Baldwin-Whitehall School District. The conclusions of the study are delimited to this area.

The results of progress data for different ability students under IPI indicated, in general, that higher ability students mastered more skills and units than did the lower ability students. However, despite the suggestion that the bright students progress faster and master more material than the slower students, the results of the standardized tests used in the study seem to raise a contradiction. These results indicated no significant difference among high, average, and low ability students in arithmetic computation or problem solving scores whenever the pretest performance was taken into account.

A possible answer to the contradiction may be that standardized tests measure content which is appropriate for a particular grade level but inappropriate for measuring achievement in the IPI program. For example, the elementary battery which is given to third and fourth grade students measures content material suitable for the third and fourth grade. In the IPI program, however, a fourth grade student is not limited to performing arithmetic tasks only on the fourth grade level. A new student entering the IPI program is given a series of tests in order to determine his starting place in the math continuum. If it is thought best for the individual, a fourth grade student may be allowed to work in second, third, fourth, fifth, and even sixth grade arithmetic skills.

Also a sixth grade student may be working with fourth grade skills in fractions during one week and fifth grade skills in addition the following week. Once mastery is indicated, the student is then permitted to do work at a higher level. The only limitation placed upon the student in how fast he can proceed within the IPI program is his ability to learn. It seems very possible that under IPI the students are gaining mastery of skills that fall outside the range of those covered by the given standardized test. That is, some may be mastering abilities that could be assessed only by giving a higher level test while some are mastering content of a lower grade level that could only be evaluated by a lower level test.

In the comparison of the experimental and control schools, it did appear that the instruction in two of the control schools, MacAnnulty and McGibney, may have operated differentially in some instances on the different ability groups. That is, in these schools the standardized test results did show that there was a difference in the gains shown by students at different ability levels. This might well be anticipated in situations where all pupils spend the school year in a concentrated study of the content of one given grade level.

The third control school, Rolling Hills, had results similar to those of Oakleaf: In either the fourth, fifth, or sixth grade and with computation or problem solving scores, there was no significant difference reported among high, average, and low ability students.

C. Recommendations for Further Research

1. The progress data of students under Individually Prescribed Instruction should be further analyzed with respect to specific skills and units mastered by each ability group. It would be interesting to find out, for example, whether or not low ability students have as much difficulty as average ability students with subtraction of two-digit numbers. This might be done by analyzing particular problems missed on work pages, the number of work pages completed, or the number of days or hours spent in mastering a specific skill or unit. This type of analysis should be useful in determining what specific content is most difficult for pupils at various ability levels.

2. Although no significant differences in progress were reported in the achievement scores of high, average, and low ability students under IPI in either arithmetic computation or problem solving, it is recognized that the scores used in the analysis of covariance treatment were scores from a standardized test. Such a test provides evidence of a student's relative proficiency with material appropriate for a given school level. It yields normative data and does not provide a basis for determining how much each student has mastered in terms of level achieved. It would seem to be worthwhile to conduct a study similar to this one using a test which is more sensitive to an individual's progress in arithmetic which may involve several grades or levels of work.

3. The achievement scores used in this study came from fourth, fifth, and sixth grade students. Perhaps it would be important to see

the results of a study which includes students in other grade levels. It may be that the lower or higher levels in the math continuum are designed in a manner that favors a particular ability group.

4. As stated previously, the results of this study gave evidence that the IPI program did not operate differentially among high, average, and low ability students. The two measures of evaluation in arithmetic were computation and problem solving. Since the IPI program also involves instruction in reading and science, it would seem beneficial to analyze the results in comparable studies in these areas.

5. In addition to achievement measures, a comparison of self-initiated activities, personality variables, and teacher-pupil interaction for different ability groups might be investigated. It would seem important to find out in the IPI program, for example, whether or not the high, average, or low ability student shows more self-initiative in arithmetic activities or which of the different ability groups report more interaction with the teacher.

APPENDIX A

IQ DATA FOR RESEARCH POPULATION

IQ Range and Mean IQ for Fourth Grade Low Students

School	IQ Range	Mean IQ
Oakleaf	89 - 105	96.250
MacAnnulty	90 - 105	97.638
McGibney	93 - 106	101.083
Rolling Hills	76 - 104	95.948

IQ Range and Mean IQ for Fourth Grade Average Students

APPENDICES

School	IQ Range	Mean IQ
Oakleaf	107 - 112	110.200
MacAnnulty	107 - 112	109.150
McGibney	107 - 114	110.214
Rolling Hills	107 - 114	110.714

IQ Range and Mean IQ for Fourth Grade High Students

School	IQ Range	Mean IQ
Oakleaf	115 - 124	119.778
MacAnnulty	115 - 133	121.200
McGibney	115 - 146	125.417
Rolling Hills	119 - 127	123.000

APPENDIX A

IQ DATA FOR RESEARCH POPULATION

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Oakleaf	89 - 105	96.250
MacAnnulty	90 - 105	97.638
McGibney	93 - 106	101.083
Rolling Hills	76 - 104	95.948

IQ Range and Mean IQ for Fourth Grade Average Students

School	IQ Range	Mean IQ
Oakleaf	107 - 112	110.200
MacAnnulty	107 - 112	109.150
McGibney	107 - 114	110.214
Rolling Hills	107 - 114	110.714

IQ Range and Mean IQ for Fourth Grade High Students

School	IQ Range	Mean IQ
Oakleaf	115 - 124	119.778
MacAnnulty	115 - 133	121.200
McGibney	115 - 146	125.417
Rolling Hills	119 - 127	123.000

IQ Range and Mean IQ for Fifth Grade Low Students

School	IQ Range	Mean IQ
Oakleaf	83 - 101	96.200
MacAnnulty	80 - 106	98.679
McGibney	77 - 106	96.000
Rolling Hills	84 - 105	99.800

IQ Range and Mean IQ for Fifth Grade Average Students

School	IQ Range	Mean IQ
Oakleaf	107 - 113	110.500
MacAnnulty	107 - 114	110.842
McGibney	108 - 114	110.437
Rolling Hills	109 - 114	111.307

IQ Range and Mean IQ for Fifth Grade High Students

School	IQ Range	Mean IQ
Oakleaf	115 - 123	117.833
MacAnnulty	115 - 141	119.381
McGibney	116 - 131	122.400
Rolling Hills	115 - 128	121.700

IQ Range and Mean IQ for Sixth Grade Low Students

School	IQ Range	Mean IQ
Oakleaf	78 - 105	96.100
MacAnnulty	95 - 106	101.616
McGibney	85 - 104	96.934
Rolling Hills	91 - 104	97.875

IQ Range and Mean IQ for Sixth Grade Average Students

School	IQ Range	Mean IQ
Oakleaf	107 - 114	110.800
MacAnnulty	107 - 114	109.883
McGibney	108 - 114	110.823
Rolling Hills	107 - 114	111.375

IQ Range and Mean IQ for Sixth Grade High Students

School	IQ Range	Mean IQ
Oakleaf	116 - 129	121.857
MacAnnulty	115 - 136	121.305
McGibney	115 - 132	121.400
Rolling Hills	115 - 133	122.834

APPENDIX B

PROGRESS DATA FOR OAKLEAF STUDENTS

1. Attendance, Number of Skills and Units Mastered, Number of Units Pretested Out Of, and Total Units for Oakleaf Elementary School Fourth Grade

A. Fourth Grade High Group

Student	**Attendance (185 days)**	**Skills**	**Units**	**Units (P.O.)**	**Total Units**
1	178 1/2	27	9	10	19
2	177 1/2	36	13	1	14
3	183 1/2	25	9	8	17
4	181	18	5	9	14
5	179	31	12	4	16
6	180 1/2	30	9	8	17
7	180	13	8	3	11
8	185	25	9	5	14
9	183 1/2	23	7	8	15
Mean	181.06	25.33	9.00	6.22	15.22

B. Fourth Grade Average Group

Student	Attendance (185 days)	Skills	Units	Units (P.O.)	Total Units
1	182 1/2	31	9	5	14
2	184 1/2	15	5	3	8
3	185	18	7	9	16
4	185	17	6	9	15
5	179	24	7	2	9
6	174 1/2	22	8	10	18
7	185	27	8	10	18
8	170	23	8	4	12
9	177	9	3	3	6
10	177	20	8	8	16
Mean	179.85	20.60	6.90	6.30	13.20

C. Fourth Grade Low Group

Student	Attendance (185 days)	Skills	Units	Units (P.O.)	Total Units
1	181 1/2	33	12	6	18
2	177	13	7	3	10
3	184	22	8	7	15
4	175	15	5	3	8
Mean	179.38	20.75	8	4.75	12.75

2. Attendance, Number of Skills and Units Mastered, Number of Units Pretested Out Of, and Total Units for Oakleaf Elementary School Fifth Grade

A. Fifth Grade High Group

Student	Attendance (185 days)	Skills	Units	Units (P.O.)	Total Units
1	185	19	8	9	17
2	183	18	9	4	11
3	179	29	9	7	16
4	185	25	8	6	14
5	178	29	9	6	15
6	172 1/2	24	8	3	11
Mean	180.42	24.00	8.17	5.83	14.00

B. Fifth Grade Average Group

1	182	26	8	7	15
2	184 1/2	28	11	6	17
3	181	22	5	5	10
4	185	21	7	9	16
5	179	37	13	7	20
6	183 1/2	22	9	9	18
7	171 1/2	36	12	4	16
8	180	20	8	5	13
9	182	30	8	2	10
10	179 1/2	29	10	7	17
Mean	180.9	27.10	9.1	6.1	15.2

C. Fifth Grade Low Group

Student	Attendance (185 days)	Skills	Units	Units (P.O.)	Total Units
1	185	13	6	3	9
2	183	23	8	8	16
3	173	15	6	8	14
4	176	22	7	3	10
5	185	25	10	5	15
Mean	180.40	19.60	7.40	5.40	12.80

3. Attendance, Number of Skills and Units Mastered, Number of Units Pretested Out Of, and Total Units for Oakleaf Elementary School Sixth Grade

A. Sixth Grade High Group

Student	Attendance (185 days)	Skills	Units	Units (P.O.)	Total Units
1	183	28	11	8	19
2	184	48	9	6	15
3	185	30	10	6	16
4	183 1/2	26	7	6	13
5	182	40	10	10	20
6	176	19	6	6	12
7	178 1/2	43	11	8	19
Mean	181.71	33.43	9.14	7.14	16.29

B. Sixth Grade Average Group

Student	Attendance (185 days)	Skills	Units	Units (P.O.)	Total Units
1	184	44	8	5	13
2	185	36	11	4	15
3	182 1/2	33	9	9	18
4	184 1/2	42	10	10	20
5	184 1/2	29	7	9	16
Mean	184.1	36.80	9	7.40	16.40

C. Sixth Grade Low Group

1	181	27	9	5	14
2	183 1/2	22	7	6	13
3	179 1/2	30	6	8	14
4	185	32	8	2	10
5	175 1/2	28	11	3	14
6	184	12	7	4	11
7	182	49	13	2	15
8	172 1/2	10	5	4	9
9	184 1/2	29	10	9	19
10	185	36	11	5	16
Mean	181.35	27.5	8.7	4.8	13.5

APPENDIX C

ACHIEVEMENT TEST BATTERIES USED IN THE EXPERIMENTAL AND CONTROL GROUPS

	1964		1965	
Grade	Test Battery	Form	Test Battery	Form
4	Metropolitan Elementary	B	Metropolitan Elementary	C
5	Metropolitan Elementary	B	Metropolitan Intermediate	A
6	Stanford Intermediate	M	Stanford Intermediate II	W

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